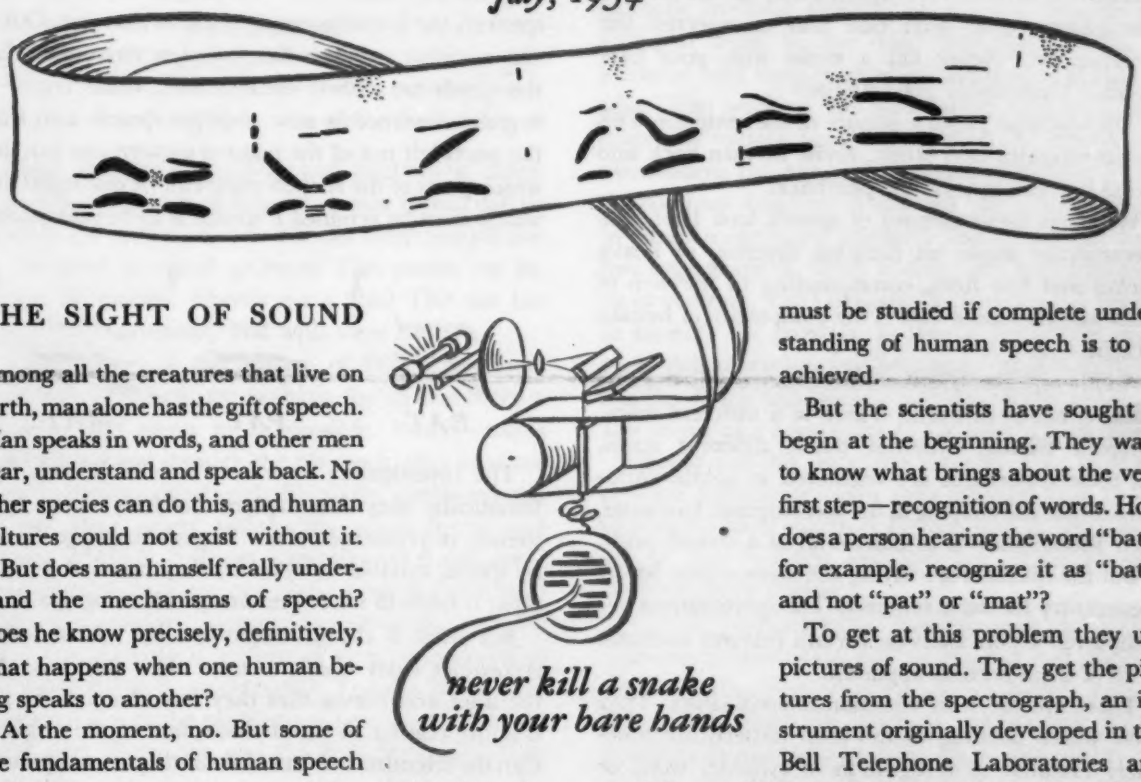
QUARTERLY REPORT

CARNEGIE CORPORATION OF NEW YORK

July, 1954



THE SIGHT OF SOUND

Among all the creatures that live on earth, man alone has the gift of speech. Man speaks in words, and other men hear, understand and speak back. No other species can do this, and human cultures could not exist without it.

But does man himself really understand the mechanisms of speech? Does he know precisely, definitively, what happens when one human being speaks to another?

At the moment, no. But some of the fundamentals of human speech and communication are now being explored in the Haskins Laboratories of New York City with the aid of a series of grants from Carnegie Corporation and other sources, and the answers are beginning to come.

Speech, of course, conveys a good deal more than just the meaning of words. The identity and personality of the speaker, the quality of his voice, the fear, the joy or other emotional coloring he gives his words, where he puts stress and emphasis—all these things and many more go to make up the living stream of verbal communication. Eventually they must be studied if complete understanding of human speech is to be achieved.

never kill a snake with your bare hands

But the scientists have sought to begin at the beginning. They want to know what brings about the very first step—recognition of words. How does a person hearing the word "bat," for example, recognize it as "bat," and not "pat" or "mat"?

To get at this problem they use pictures of sound. They get the pictures from the spectrograph, an instrument originally developed in the Bell Telephone Laboratories and specially modified for the purposes of this research. When words are spoken into the microphone of the spectrograph, this machine puts on film a visual record of the sound patterns involved. This is, in a very literal sense, visible speech.

These sound patterns, or spectrograms, can then be put into a reproducer that will translate the visual patterns back into sound. This reproducer—called a pattern playback—has been developed into an important new research tool in the course of the studies on speech at the Haskins Laboratories.

The process of moving from sound to sight seems deceptively simple. The experimenter speaks into the microphone some such odd and unexpected test sentence as: "Never kill a snake with your bare hands." Undeniably good advice!

The machine yields a picture of the sentence. This the investigator may study, revise or turn back into sound by putting it on the playback.

What do these pictures of speech look like? The spectrogram shows an intricate layering of heavy strokes and fine lines, corresponding to the web of tones and overtones that is the complexity of human speech.

Another speaker tries the same sentence. This time the spectrogram is different. There is a different voice, different timing, different tones, different stress. All these differences are registered in subtle variations of line and shading in the spectrogram. In a sense, each spectrogram is as individual as a thumb print.

But the speakers are saying the same words. Many speakers try the same sentence. The spectrograms are compared. Upon analysis, certain features common to all of them become apparent.

These are the least common denominators. They show which portions of the total pattern are absolutely essential to recognition of syllable, word or phrase. These are the fundamentals. Is it possible to disregard some of the feathery surrounding lines that identify the individual speakers and their manner of speaking and still hear intelligible speech?

The scientists try just that. With white paint they make tracings of the spectrogram on transparent tape, ignoring the fine detail and tracing in only the broad outlines. The painted pattern that emerges is far simpler than the original, a pattern now of only a few dots and strokes—a kind of cartoon of the speech picture.

This is fed into the playback. Gone is the human warmth and color—the New England twang of this speaker, the bubbling sense of fun of that one. Out of the machine comes a flat, colorless monotone—but the words are clearly recognizable. What began as a *spoken* sentence is now *simplified* speech, and from the parts left out of the painted pattern one can find which parts of the spoken word can be discarded and which must be retained if speech is to be understood.

The investigators have here a reliable tool. Systematically they can explore the forty or so basic sounds, or phonemes, of our English language. Sound by sound, syllable by syllable, they can find out just what it takes to make human speech recognizable.

But what if the investigators didn't have actual recordings from which to trace their patterns? Are the lines and curves that they have been using sufficiently regular to stand alone, free of the original? Can the scientists use "standardized" patterns painted freehand, and can such contrived patterns also convey intelligible speech?

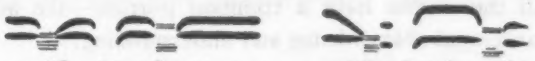
They can. The freehand patterns can be made to speak as clearly as those that have been traced from a spectrogram. This is *synthetic* speech in its truest sense.

When the scientists try one of these freehand patterns on the playback, the result is eerie. That flat monotone—the very voice of a machine. Another of those maddening, semi-nonsense test sentences: "A big, bad man demanding money can kill you. Bang! Bang!" The hearer can recognize every word, every

syllable. This is speech. Yet no human ever spoke it. No sound, no breath, no vocal cord brought this into being. A pattern of paint on film—and you have speech.

The scientists can go much further. By altering the pattern in slight and subtle ways, quality and accent can be changed in predictable fashion. Thus, the word "Alabama" can be given the characteristic drawl of a Southerner, or the accent of a Frenchman. It is possible to work with any language, analyzing its characteristic modes of pronunciation and its dialects, and to compare with a new order of precision the various languages of the world.

"ALABAMA"



. . . with a French accent *. . . with a Southern drawl*

These findings open large and fascinating vistas. If sounds as complex as those of human speech can be reproduced with a paint brush, can other sounds also be captured in visual patterns? Can music, for instance, be painted directly on a film? This too has been tried—amusingly and with some success.

Again, there is the matter of shape. Can one recognize a triangle, for example, by its sound? In a measure, this seems to be possible. When various triangles are put through the playback, they produce roughly comparable sounds. Similarly, circles painted on the films sound rather like other circles and ellipses. There is, it seems, a sight-sound transform—a relationship between our perceptions of "pattern," whether experienced through the eyes or through the ears. The theoretical interest of such phenomena to the psychologist is considerable. There is a practical relevance also to the problems of helping the blind to "see" with their ears, and the deaf to "listen" with their eyes.

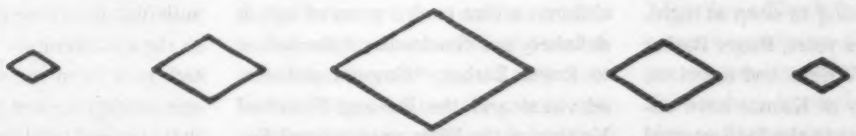
The principal investigators in these studies are Franklin S. Cooper, associate director of the Haskins Laboratories, Pierre Delattre, professor of Romance languages at the University of Colorado, and Alvin M. Liberman, associate professor of psychology at the University of Connecticut. Many other scholars from many lands have helped in the work.

The Haskins Laboratories were established in 1935. They are incorporated in New York State as a nonprofit educational institution for basic research and research training. The staff numbers approximately forty. The organization is devoted to the role of "uncommitted investigator," prepared to explore scientific frontiers and the borderlines between established fields in the hope that the findings so achieved may become growing points of fresh knowledge. The work of the laboratories has been supported by various agencies including the Rockefeller Foundation, the American Philosophical Society and the National Academy of Sciences, and to some extent by funds contributed privately and by certain business organizations. Work is done also under government contract. The Carnegie Corporation has helped to support the program in speech perception since 1947 with grants totaling $200,000. Caryl P. Haskins, founder of the laboratories and director of research, also serves as a consultant to Carnegie Corporation.

Cooper and his associates estimate that they are perhaps halfway through their avowed task of exploring the basic sounds of English speech. They have gained new insights, and they see important new areas yet to be explored.

This is basic research, research into the central processes of perception and recognition that underlie the understanding—and the more effective use—of the spoken word. Its ultimate applications are as broad as human society itself, for if men are to cooperate they must first communicate.

Triangles produce roughly comparable sounds . . . *so do circles and ellipses.*



Can you translate sight into sound and sound into sight? All this is for the future.

What Is the Use of a Newborn Child?

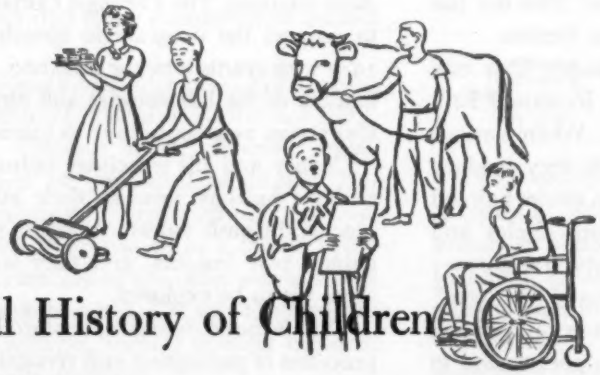
THE charter of Carnegie Corporation specifies that the Corporation's income shall be used for "the *advancement* and *diffusion* of knowledge and understanding." This issue of the Quarterly Report is devoted primarily to some current efforts to carry out the first of these two mandates.

Andrew Carnegie did not attempt to specify the fields in which increase of knowledge would most profit his fellow men. As a student of history, whose life spanned a period of great social, economic and technological change, he knew that even the wisest men cannot predict what knowledge will be most valued or needed in the unforeseeable future.

In his first letter of gift to the trustees of the Corporation, Mr. Carnegie said, "Conditions upon the earth inevitably change; hence no wise man will bind Trustees forever to certain paths, causes or institutions. I disclaim any intention of doing so. . . ."

The studies described in this report lie in a variety of fields. Some are concerned with man's never-ending quest for greater understanding of the physical world in which he lives. Others deal with the problems arising out of men's association with one another. All the studies have a common purpose—the advancement of knowledge and understanding.

How, when, where, by whom will this new knowledge be used? The question recalls Benjamin Franklin's answer to the skeptic who asked, "What is the use of your new invention?" Replied Franklin, "What is the use of a newborn child?" ■



A Natural History of Children

HOW do American children spend their days? We know in great detail how rats, monkeys and brook trout spend their time. We also have daily records on the behavior of volcanoes and tides. But we have few scientific records of what a boy actually does and says during breakfast or how he lives a day from opening his eyes in the morning until going to sleep at night.

For the past six years, Roger Barker and Herbert F. Wright and associates at the University of Kansas have addressed themselves to the fundamental task of charting the daily lives of children—gaining facts essential to an emerging science of human behavior.

The Barker-Wright team has worked among the children of the small town of "Midwest," a fictional name for an actual town which exhibits, in rather pure form, one thread of the complex fabric of American culture. Midwest, with its 721 residents, including 119 children under twelve years of age, is definitely not "backwater." According to Roger Barker, "Gamma globulin, television and the Revised Standard Version of the Bible are accepted features of the local culture."

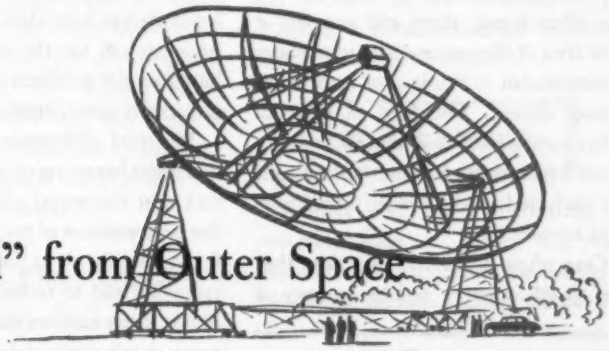
The investigators have used observational methods, familiar to students of natural history, to describe the everyday behavior and psychological world of the children. They have also assembled similar data on children in neighboring towns and institutions who have been seriously disabled by cerebral palsy, poliomyelitis and congenital heart defects. Carnegie Corporation funds helped with this latter phase of the study.

The natural history of normal children, when compared with similar records on physically disabled children, reveals some striking differences. Take the matter of "feeling needed," a matter of basic importance to every human being. If one were to tabulate all the activities involving responsible service to the community—not an impossible task in a town the size of Midwest—one would discover the surprising fact that normal children under twelve perform twenty-four per cent of these

activities. These are activities of real importance not only in "children's settings," such as school clubs and Scout organizations, but also in settings designed primarily for adults. Almost every meeting of the Women's Club and Presbyterian Ladies Aid depends on children for an important part of the program. Children clerk in grocery stores; they solicit funds for the Red Cross; they sing in the junior choirs at church services. In terms of its available manpower, Midwest needs children to get its daily work done. And the older a Midwest child grows, the more responsible and respected are his positions. As Professor Barker puts it, "A modern Pied Piper would have left Midwest not only emotionally distraught but economically and socially crippled!"

The social world of handicapped children is infinitely more limited. The investigators observed children who lived in an excellent residential school nearby. They found that these children occupied almost no positions of real responsibility, and those which they did occupy were all in groups meant only for children. "*Apartheid* was a fact here," Barker says. "The only evidence these children had of their importance and value were the affection and respect they received from their peers and teachers. And growing up in this school provided few advantages; responsible jobs didn't increase, nor did the child's sense of his own worth."

This finding is but one of many that appear in *Midwest, U.S.A. and Its Children* by Barker and Wright, which will be published by Row, Peterson & Co. late next fall. The authors believe the findings may point the way to future study of other children, living in suburbs, slums, farms and cities, and of the effects of these various environments on their lives. ■



"Sound" from Outer Space

SOME of the unsolved mysteries of the universe, such as the nature and origin of radio waves that come from outer space, and the existence and location of stars that cannot be seen or photographed even with Mt. Palomar's mammoth telescope, are to be explored by Australian scientists with the help of a Carnegie Corporation grant.

A $250,000 appropriation, to be administered by the Commonwealth Scientific and Industrial Research Organization in Australia, will provide part of the cost of constructing a giant "radio-eye" or "dish"—technically called a parabolic reflector or receiving antenna—250 feet in diameter and some sixty feet deep. It will take three years to build the reflector and to mount it so that it can be tilted or rotated in any direction and aimed at any segment of the heavens.

The "dish" has been designed by the Radiophysics Laboratory of the Commonwealth Scientific and Industrial Research Organization under the direction of E. G. Bowen, a British-born physicist of international reputation, and his chief assistant, J. L. Pawsey. Dr. Bowen's work lies in the relatively new field of radio astronomy, which is now recognized as an essential aid in astronomy's classical task of exploring the nature of the universe. Developments in radio astronomy date back to 1932 when it was discovered that radio waves originating beyond our solar system can be detected on earth. As a result of intensive world-wide research over the past few years, such radio waves are now used to study a broad range of astronomical phenomena, including the sun, the moon, the Milky Way (the central galaxy containing our solar system) and remote galaxies in outer space.

One of the most striking findings, to which members of Bowen's group in Australia have contributed materially, is that radio waves come not from generalized regions of known and visible stars but seemingly from "radio stars" that give off little or no light and thus cannot be seen with any telescope. The new "dish" will help to find and identify these invisible stars, as well as investigate other suggested sources of radio waves—stellar explosions, the action of hydrogen gas in interstellar space, or collisions of galaxies.

Another reflector of comparable size and power is now under construction at the University of Manchester, England. Funds for the Manchester development are being provided by the British Government and the Nuffield Foundation. Ever since plans for the British "dish" were announced about two years ago, scientists have hoped for a similar unit that would make it possible to explore the stars in the southern hemisphere, particularly the Magellanic Clouds formation, with the same thoroughness that the Manchester equipment will make possible in the northern hemisphere. The installation at Sydney may be the answer to their prayer. ■

A MATTER OF DEGREE

by Vannevar Bush

Is the study of human behavior inherently "less scientific" than the study of natural phenomena? Vannevar Bush, president of the Carnegie Institution of Washington and a trustee of Carnegie Corporation, recently expressed his views on this widely disputed subject. What he wrote seemed particularly appropriate for this issue of the Quarterly Report, which deals with research in both the natural and social sciences.

THERE is a great deal of confusion about the essential differences between the natural and the social sciences. Often the distinction is made that the social sciences are observational in nature, whereas the natural sciences are experimental. In astronomy and also in geology, we have observational sciences completely within the framework of the natural sciences. One does not manipulate the stars—he merely takes what he gets, measures it as well as he can and proceeds to construct his theories. Exactly the same thing is true if one is observing, for example, the impact of migration on a primitive people.

It is also sometimes stated that one can measure precisely in the natural sciences and cannot do so in the social sciences. This again is an incorrect criterion. Some of the data of the social sciences is quite precise—for example, much of the material in the census. On the other hand, there still remains a vast area of the natural sciences where measurement is crude and sometimes almost absent. The field of genetics offers examples of this and so do many other fields which by common consent are included in the broad term "natural science."

One often hears the assertion that the social sciences would prosper if they would carry over the method of the natural sciences. But there is no such thing as *a* method of the natural sciences; there is a great variety of methods. Moreover, to try to carry over bodily methods of approach from one branch of science to any other leads always into difficulties, as would be expected, for the method must be based on the problem in hand and not on *a priori* considerations.

The real difference between these two great branches of science lies in the fact that the social sciences deal with the performance of human beings. It is far more difficult to "measure" human behavior and to reduce all arguments about it to numbers than it is to do the same thing with molecules. But it is worth noting that even the physicists, when dealing with interactions inside the nucleus, have abandoned all of the usual mathematical formulations and are proceeding in terms of arguments which at times border on the mystical.

One cannot specify a human being in the same way that he can specify a chemical compound. But again be it noted that the chemists, in dealing with proteins, are in much the same situation for they can neither specify the atomic arrangements involved nor can they predict what characteristics one of their chemical modifications may produce. The difference is hence a matter of degree as far as the use of measurement is concerned. Also one should note that there has been enormous progress in the last decade or two in reducing to measurement many matters in the field of the social sciences which were formerly thought to

THE CORPORATION TRUSTEES

John W. Gardner

Newest trustee of Carnegie Corporation is JOHN W. GARDNER, who since 1949 has been a vice president of the Corporation. He was elected to the Board of Trustees at its May meeting.

A native of California, Mr. Gardner received his A.B. and A.M. degrees from Stanford University. After receiving his Ph.D. from the University of California, he taught at Connecticut College and Mount Holyoke College.

Mr. Gardner joined the Carnegie Corporation staff in 1946, following his release from the U.S. Marine Corps Reserve. He terminated his active military service with the rank of captain, having served with the Office of Strategic Services in Washington, D.C., Italy and Austria. He now holds the rank of major in the Reserve.

Mr. Gardner is also vice chairman of the board of trustees of the New York School of Social Work. He is a member of the Council on Foreign Relations; the American Academy of Arts and Sciences; the Ford Foundation's advisory committee on international training and research; and the policy and planning board of the American Psychological Association.

be beyond reach from this standpoint. And one cannot disregard the fact that there has been great science which involved very little in the way of measurement and mathematical formulation. Science does not always lean on the deflection of a needle or the dip of a balance.

There is one effect which is important in weighing the validity of any scientific effort. As rapidly as a science becomes precise and subject to mathematical treatment, there is less argument on the basis of balance of evidence, and opinions become to a great extent subject to test in a universally accepted form. The social scientists still do not have the means for insisting upon rigor in every case where rigor is necessary. They are making great progress along this line, but there is here still a real difference in the way in which the natural scientist and the social scientist proceed.

Corporation Plans Office Move in Early Fall

For the second time in its forty-three year life, Carnegie Corporation will change its quarters. Beginning about September 15, offices will be located at

589 Fifth Avenue, a new building on the southeast corner of Forty-eighth Street in New York City.

The Corporation has always favored Fifth Avenue. Its first offices were at 576 Fifth. In 1920, it moved to its present location in the Guaranty Trust Building, a location familiar to almost two generations of scholars.

Hail, Columbia

Columbia University, celebrating its two hundredth anniversary this year, had already reached the ripe old age of 167 when Carnegie Corporation was "born" in 1911. Despite this considerable difference in years, relations between the University and the Corporation have been close and, from the Corporation's standpoint, most helpful.

Nicholas Murray Butler, president of Columbia from 1901 to 1945, was a trustee of the Corporation for twenty years and chairman of its board from 1937 to 1946. Frederick P. Keppel, who directed the Corporation's activities as president for nineteen years, was a graduate of Columbia College, class of 1898. Mr. Keppel served as secretary of the University and dean of Columbia College, resigning the latter post to become Assistant Secretary of War in 1917. R. C. Leffingwell, the present chairman of the Corporation's Board of Trustees, who received his undergraduate education at Yale, is a graduate of Columbia Law School.

Over the years, the Corporation and the University have enjoyed a fruitful partnership in many programs for "the advancement and diffusion of knowledge and understanding." Among the current Columbia programs supported in part by Corporation funds are a program in Oriental civilization in Columbia College; the Citizenship Education Program conducted by Teachers College; a program in American civilization at Barnard College; and a recently launched program in East European studies in the School of International Affairs.

NEW GRANTS

At the May meeting of its Board of Trustees, Carnegie Corporation appropriated $2,069,900 from its available income, now estimated at $6,998,000 for the fiscal year 1953–54.

From this latter sum, grants totaling $3,957,200 were made earlier in the fiscal year, which began October 1, 1953, and $1,007,000 has been set aside to meet commitments, including those for teachers' pensions, incurred in previous years. A balance of $277,000 remains to be appropriated. It is the policy of the Corporation to spend all its income in the fiscal year in which it is received.

A complete listing of grants for each year is given in the Corporation's Annual Report. Among the grants voted recently are those listed below.

United States

University of Alabama, for a study of its educational program, $150,000.

University of Chicago, Center for the Study of American Foreign Policy, for research on United States' participation in world affairs, $75,000.

National Bureau of Economic Research, for support of research and for fellowships, $200,000.

National Civil Service League, for preparation and publication of a comprehensive book on civil service law, $40,000.

University of Puerto Rico, for a program of faculty research fellowships, $200,000.

British Dominions and Colonies

Commonwealth Scientific and Industrial Research Organization, Australia, for support of research in the field of radio astronomy (see p. 5), $250,000.

South African Council for Scientific and Industrial Research, toward costs of a mobile testing laboratory, $11,200.

Sounding the Communist Mind

Most people would agree with Gabriel Almond, a political scientist at Princeton, when he says, "No matter what the struggle, the more you know about your enemy, the more effective you'll be in dealing with him."

This precept underlies Professor Almond's new book, *The Appeals of Communism*, which the Princeton University Press is publishing in October. The book, based on a study conducted by Almond and his associates in the Center for International Studies at Princeton, contains the largest, most carefully selected body of factual data so far collected on the kinds of social situations and attitudes which contribute to susceptibility to Communism and defection from it. The study got under way in 1950; Corporation grants for the project total $41,500.

In a recent interview, Almond talked about the rationale of the study: "After World War II, people became increasingly aware of the dangers of Communism. But they also tended to simplify the problem. There was a massive lumping of Communism as a vague, threatening, generalized enemy. A more discriminating perception of the Communist movement is of utmost importance if we hope to encourage further defections here and abroad."

Almond's study is rich in unusual findings, culled from intensive interviews with 221 ex-Communists in the United States, England, France and Italy. Readers may be surprised to learn that about half of these ex-Communists were "conformists" rather than "deviants": their families' political background had been leftist or radical; in joining the party they clung to inherited family patterns, rather than rebelled against them. When they left the party, only one per cent swerved to the extreme right, and only six per cent were converted, or returned, to religion; the bulk went to the moderate, non-Communist left.

One major finding of the study involves the striking difference between what Almond calls the "exoteric" and "esoteric" Communist party. The exoteric party is a myth for popular consumption—a party of militants, championing the oppressed and downtrodden everywhere. A major appeal of the party lies in its public stands, tailor-made to capitalize on local grievances in the host country. But behind this public-relations front is the esoteric party, with one exclusive aim: naked, ruthless POWER. While this dichotomy is by now fairly well-known in the West, Almond found that the overwhelming majority of ex-Communists interviewed were unaware of the esoteric nature of Communism when they joined the party. "Typically, a person comes into the party before becoming a Communist—makes a commitment before realizing the basis for it," one respondent stated.

Is this dichotomy a cause for defection? Decidedly so, Almond thinks. A significant number of party members break away when they realize the party's unrelieved power orientation. A French labor organizer is repelled

when "for the good of the party" he is told to wreck the union he spent ten years building. Or the American minority group member grows sickeningly aware that "civil rights" is a tactical slogan, not an abiding concern with the party. Almond believes findings such as these yield significant lessons. He states, "It is a great error to assume that all persons in the party are equally 'members of the Communist conspiracy.' If we do, we overlook significant vulnerabilities of the movement that can be exploited to our advantage. The more we force the party to reveal its true nature, the more likely we are to encourage wholesale defection from it."

The Appeals of Communism also traces the anatomy of Communist hierarchies in the four countries covered, includes psychiatric case histories of thirty-five Communists, and outlines situations that encourage defection.

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